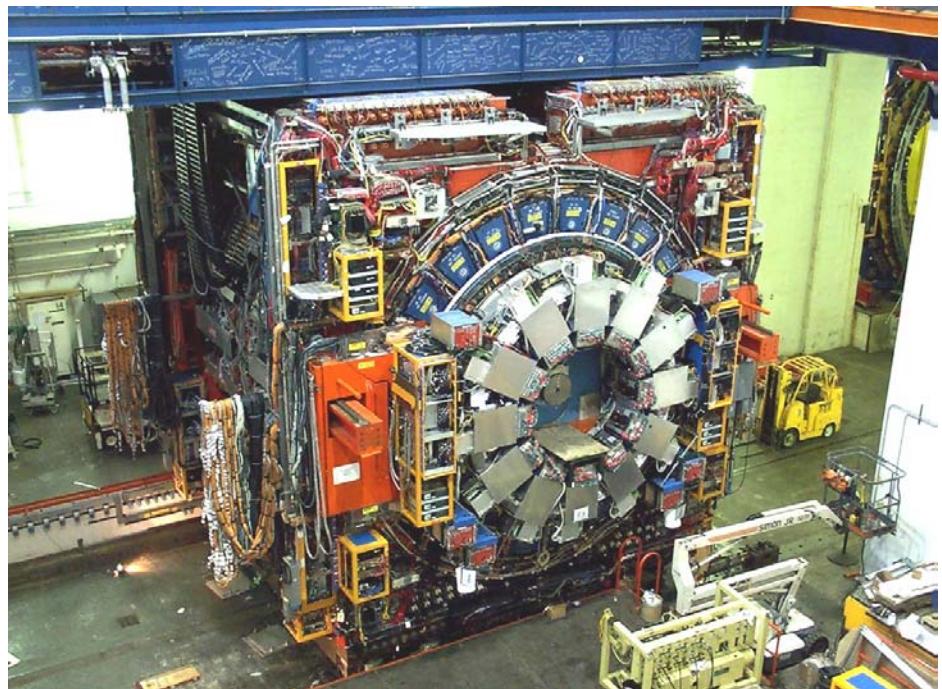


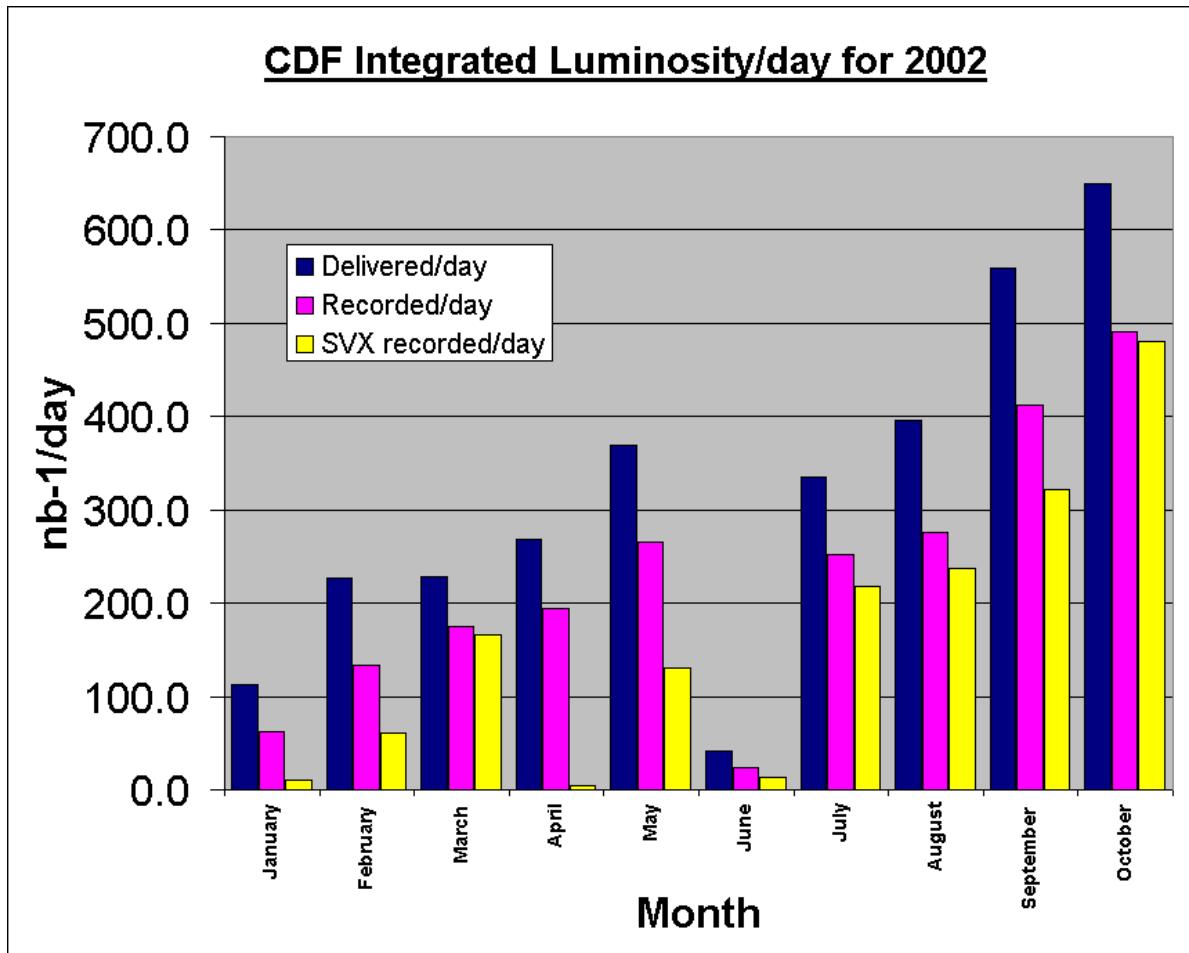
DOE Machine Review



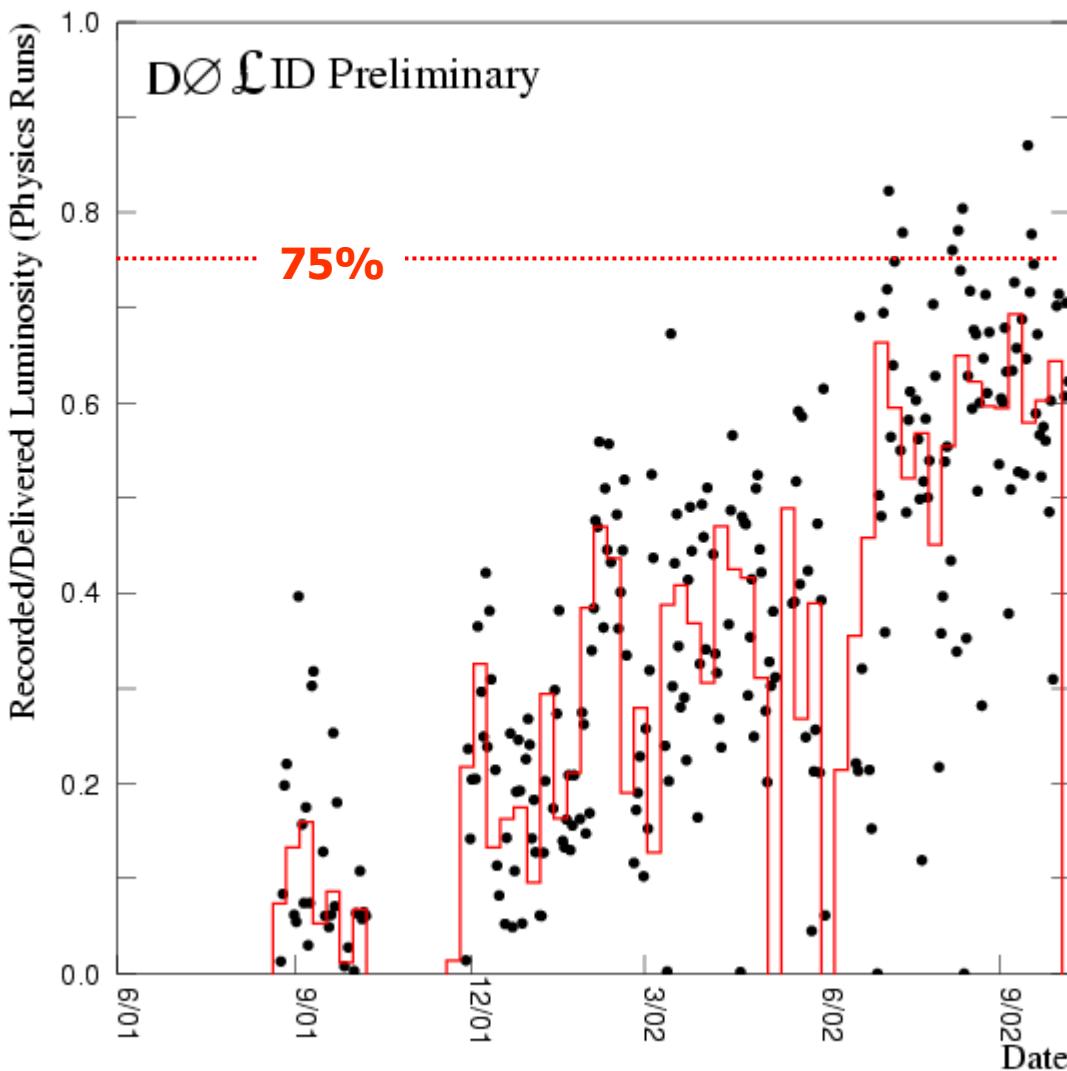
Viewpoint CDF&D0 Exps.
(>1300 Physicists+135
Institutions+30 Countries)

Al Goshaw, Nigel Lockyer (CDF Collaboration)
John Womersley and Jerry Blazey (D0 Collaboration)

Luminosity/Day 2002



$$\text{Overall D}\emptyset \text{ efficiency} = \frac{\text{Recorded luminosity}_{\text{physics runs}}}{\text{Delivered luminosity}}$$



Major effort to improve our performance

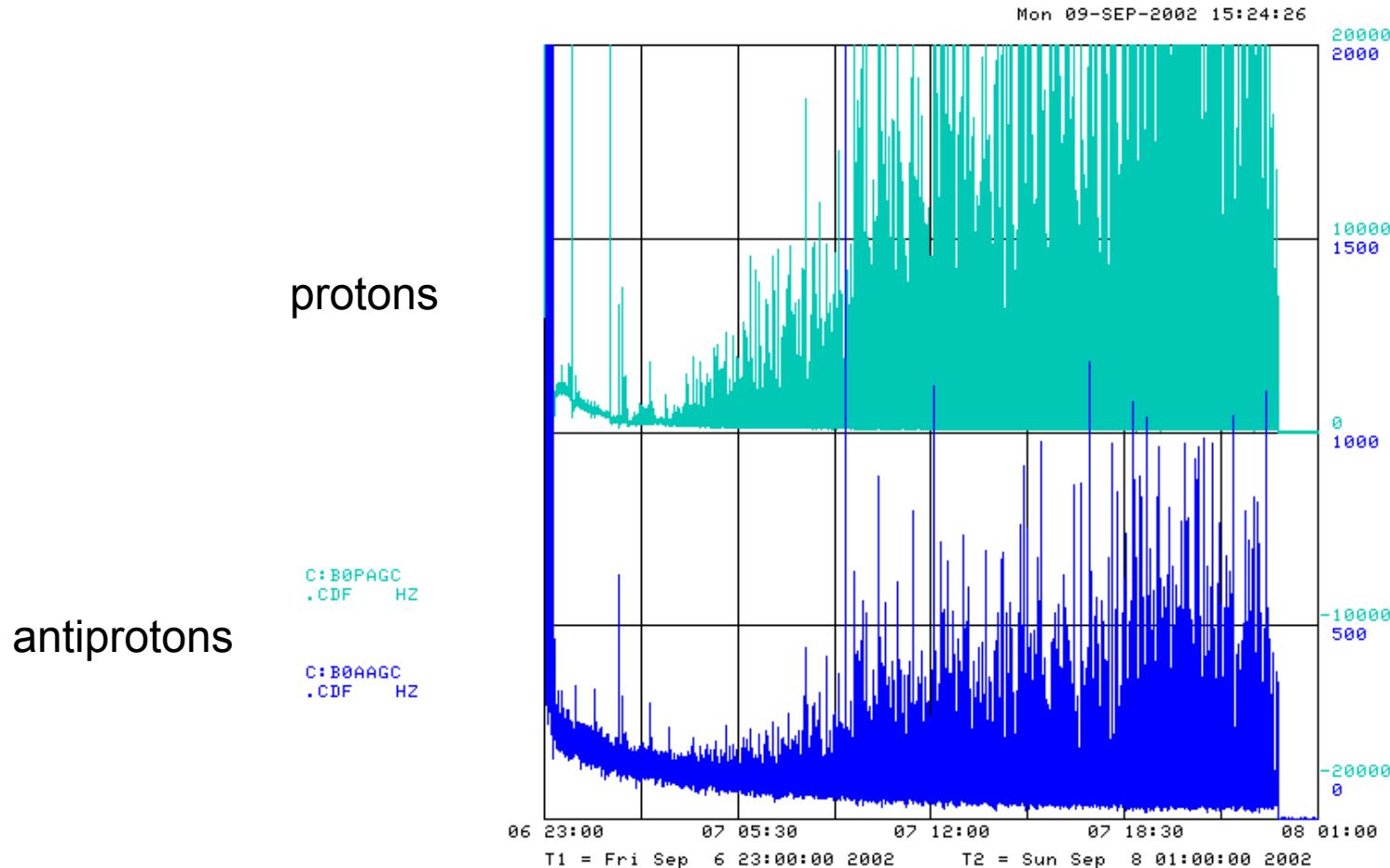
Averaged ~ 60% in September

Averaging ~66% in October so far 71% last week

The trend is good

**Immediate goal:
75%**

Current in Abort Gap-No TEL

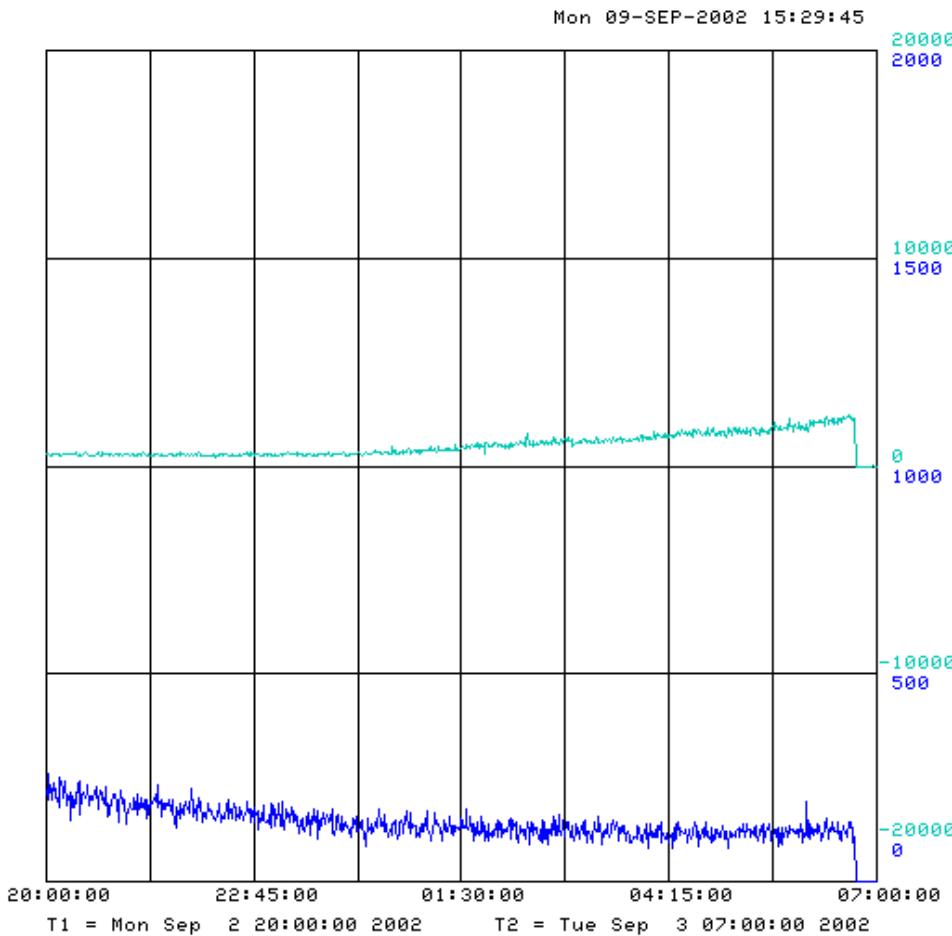


Current in Abort Gap-TEL ON

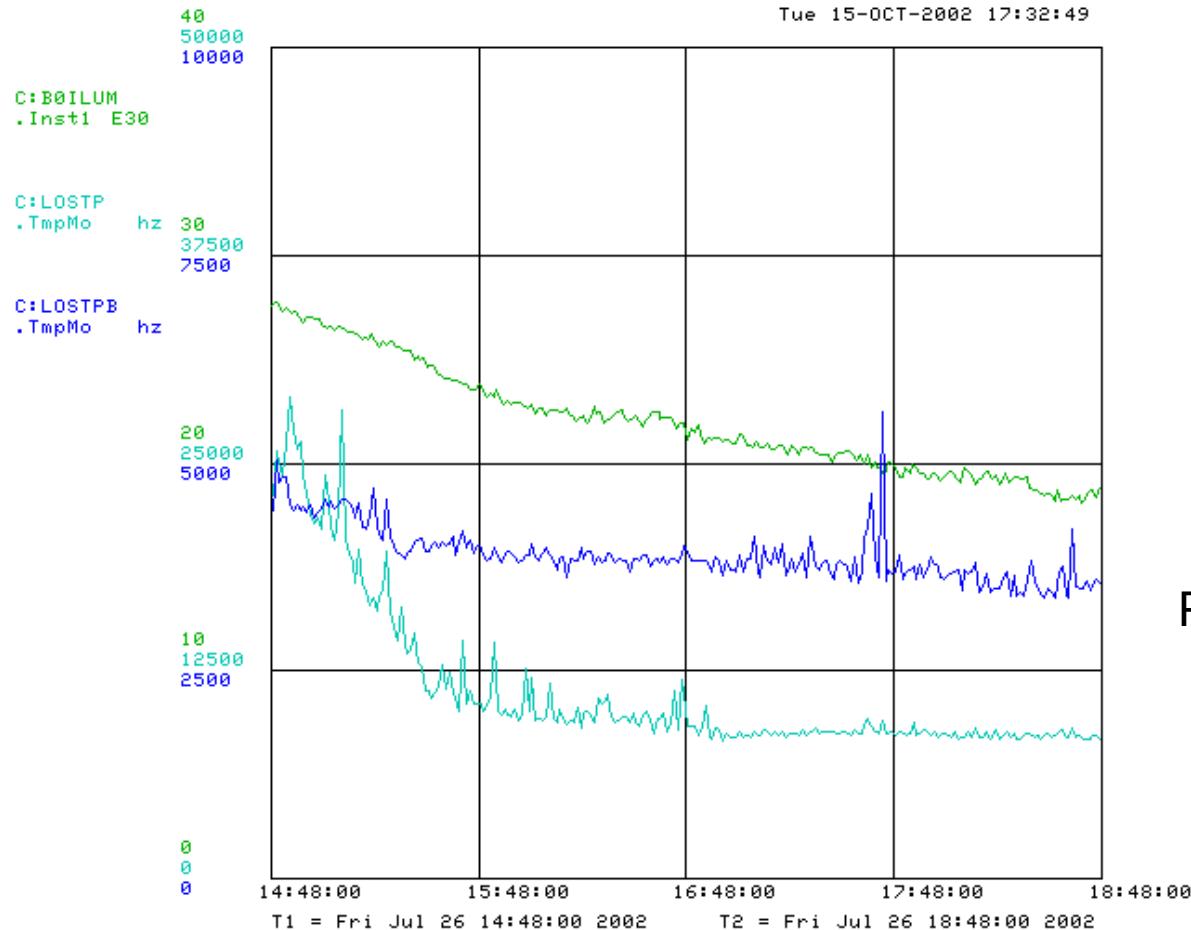
Same scale

protons

antiprotons

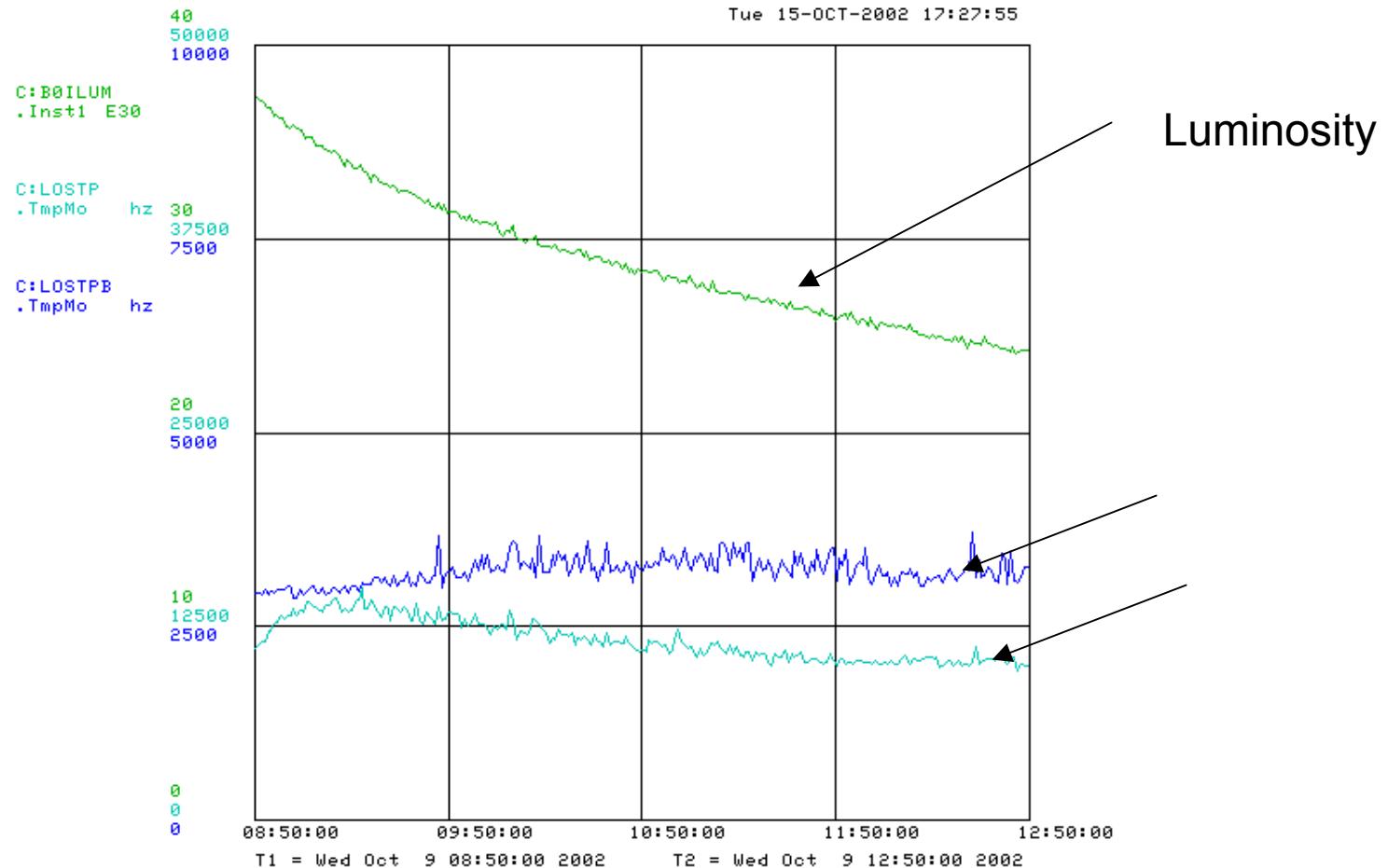


Losses In July-too high to run

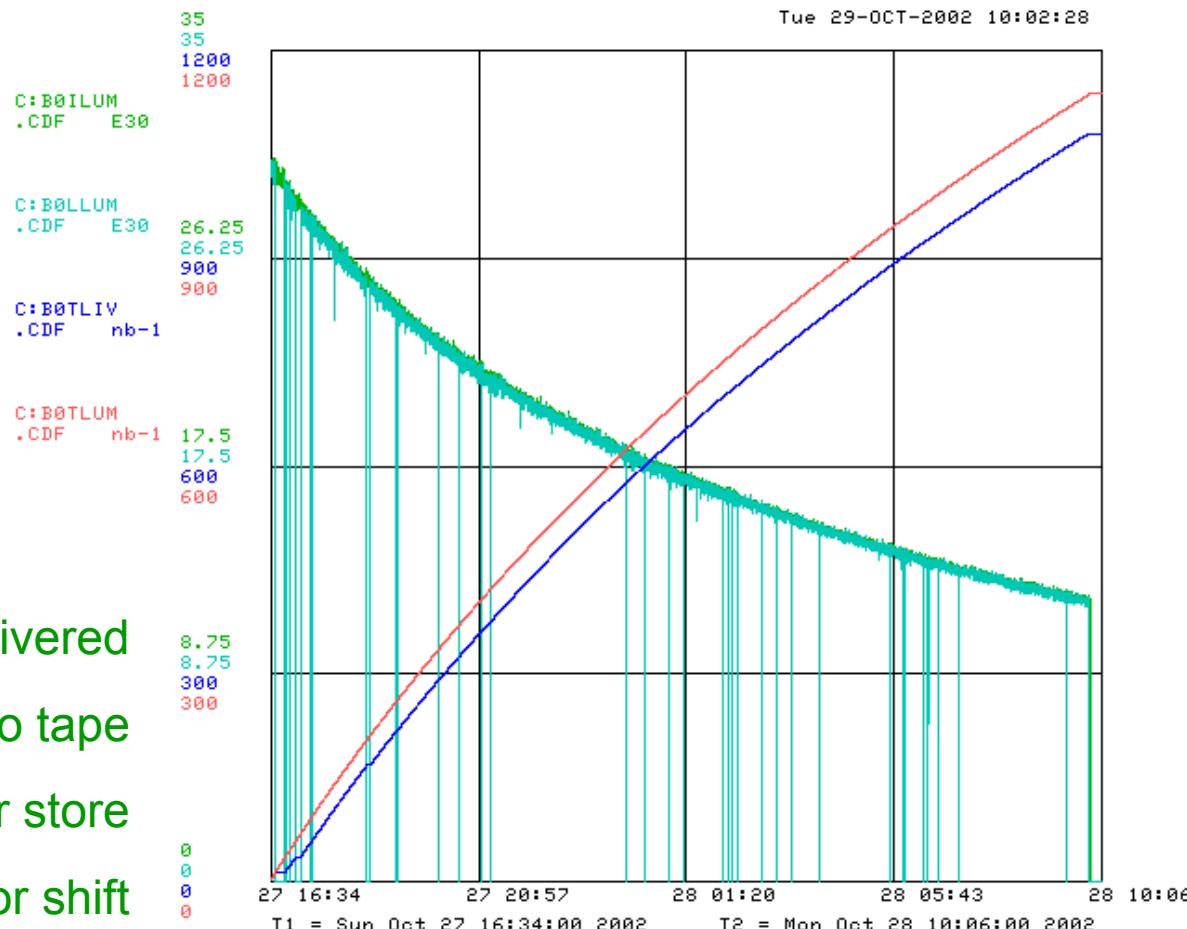


Luminosity
Protons loss
Antiproton
loss

Reduced Losses for Record Store

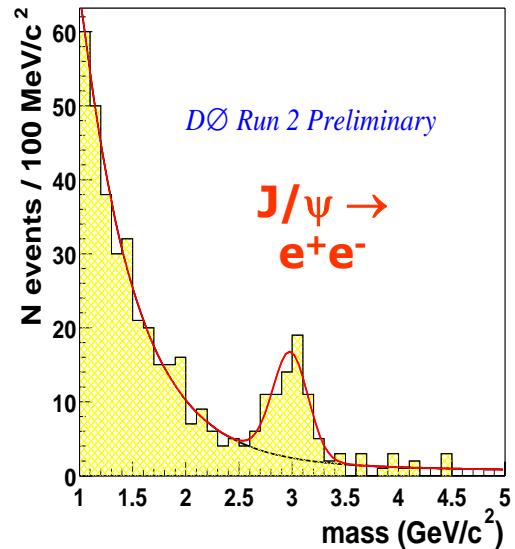


CDF Record Run Efficiency



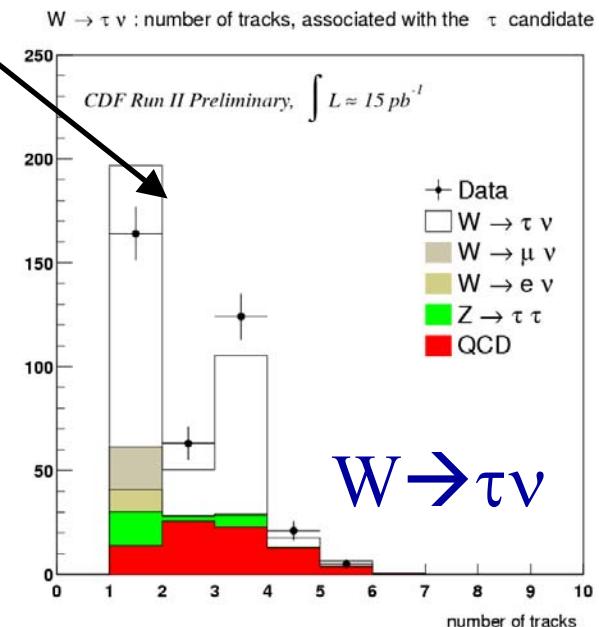
Status of DØ

- Detector is working well and recording physics quality data
 - Silicon and fiber tracker hit efficiencies 97-98%
 - Physics trigger list running
- Emphasis on operational efficiency
- Improvements in trigger for higher luminosities
 - Silicon vertex trigger (NSF funded) is under construction
 - Expanded offline farm
- Intense work on offline reconstruction, tracking efficiency, etc.



CDF-II detector is recording publication-quality data

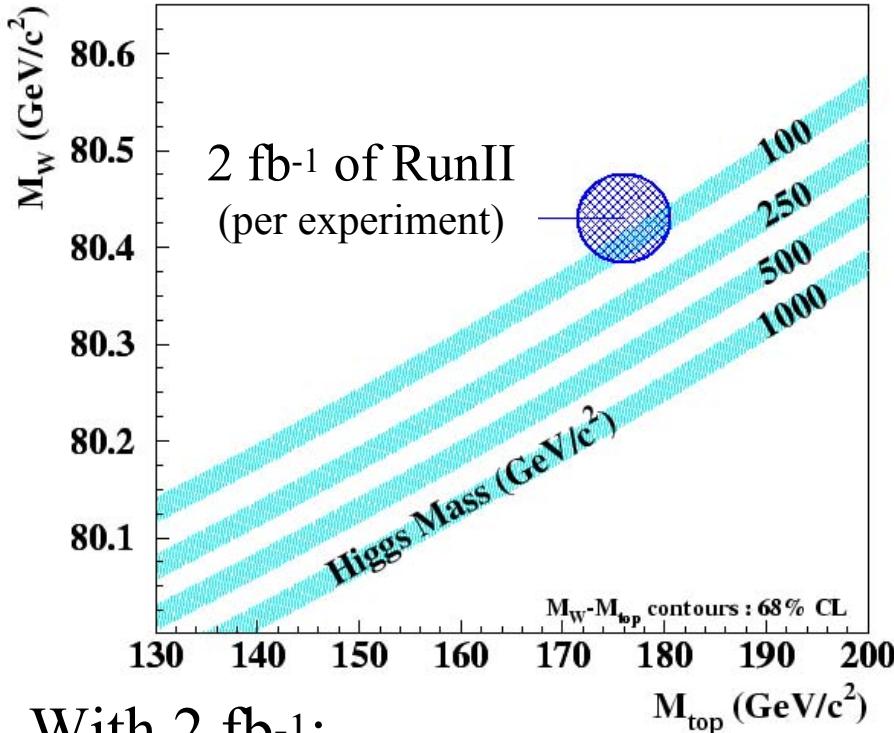
- Stable physics running established in early 2002
 - Complete Physics Trigger Table
 - ~140 triggers(e, μ , τ , ν , γ , jet, displaced track, b jet, ...)
- 75/pb recorded to tape October 2002
- COT tracking performance excellent
 - $\varepsilon = 99 \pm 1\%$ (L3/offline reconstruction)
- High Trigger efficiency
 - $\varepsilon \sim 100\%$ (L1 calorimeter trigger)
 - $\varepsilon = 96.1 \pm 0.1\%$ (L1 track trigger)
- Efficient Shift Operation
- Offline Farms keep up
- $H \rightarrow \tau \tau$ will be important



Physics Opportunities Run2

- Explore the high energy frontier
 - Experiments will guide theory
 - Probe high statistics top
- No clear paradigm for new physics
 - SUSY, extra dimensions, leptoquarks.....

Electroweak Measurements and SM Higgs



- $\Delta M_W = 30 \text{ MeV/exp}$
- $\Delta M_{\text{top}} = 3 \text{ GeV/exp}$
- start having sensitivity to SM $M_H > 115 \text{ GeV}$

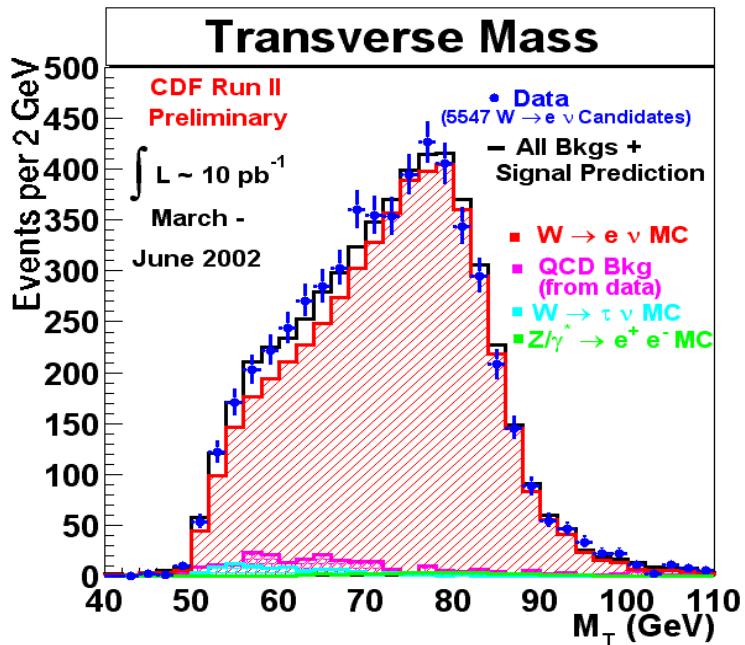
Tevatron upgrades:

- luminosities of 2×10^{32}
 $\int \mathcal{L} dt = 2 \text{ fb}^{-1}$
- $\sqrt{s} = 1.96 \text{ TeV}$
 - $\sigma(W), \sigma(Z) \sim 10\%$ higher
 - $\sigma(t\bar{t}) \sim 35\%$ higher

Detector upgrades:

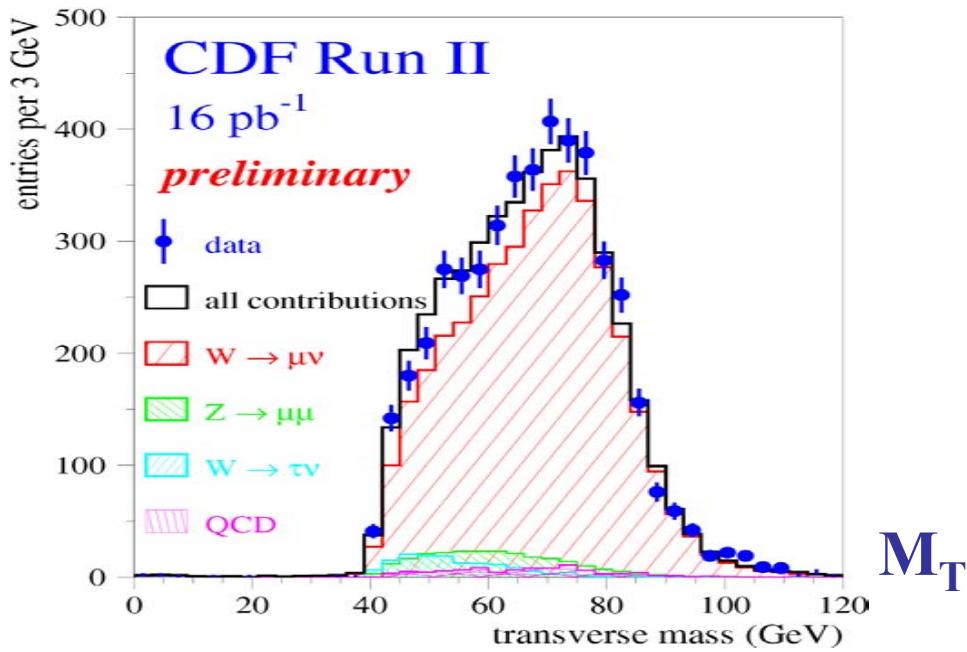
- increased b-jet and lepton ID acceptance and triggering
- performance on track to meet expectations

Measurements of $\sigma B(W \rightarrow e\nu, \mu\nu)$



5547 candidates in 10 pb^{-1}

$$\sigma_W * \text{BR}(W \rightarrow e\nu) \text{ (nb)} = 2.60 \pm 0.07_{\text{stat}} \pm 0.11_{\text{syst}} \pm 0.26_{\text{lum}}$$



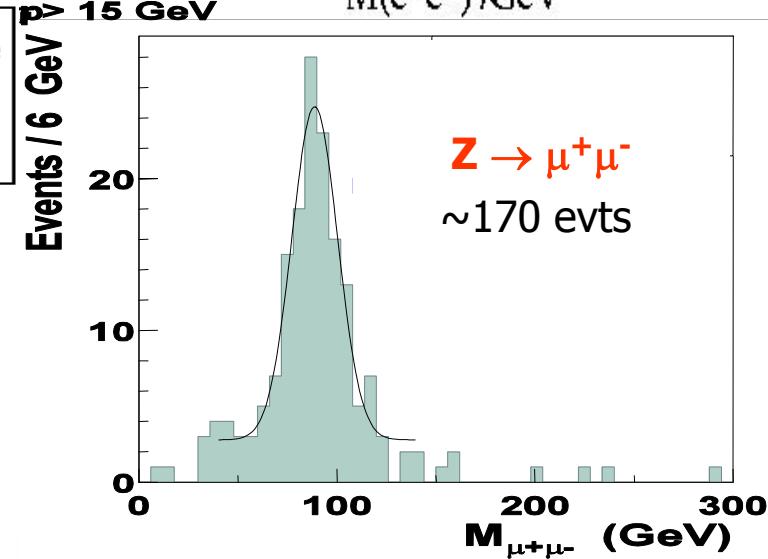
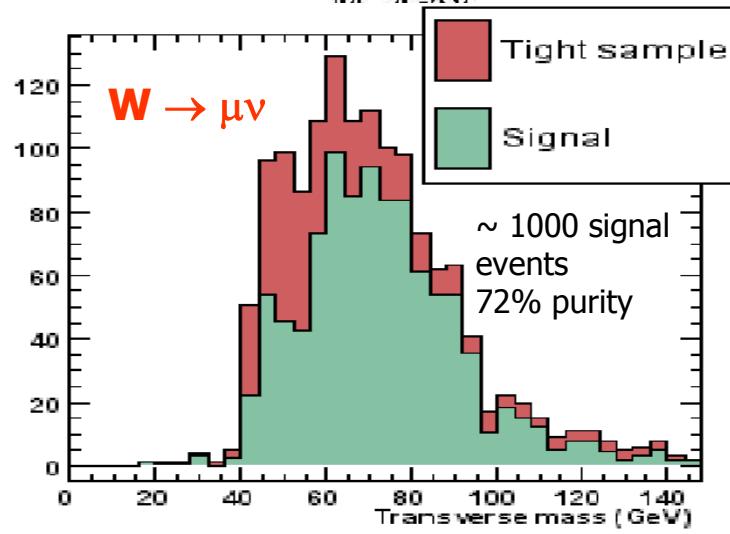
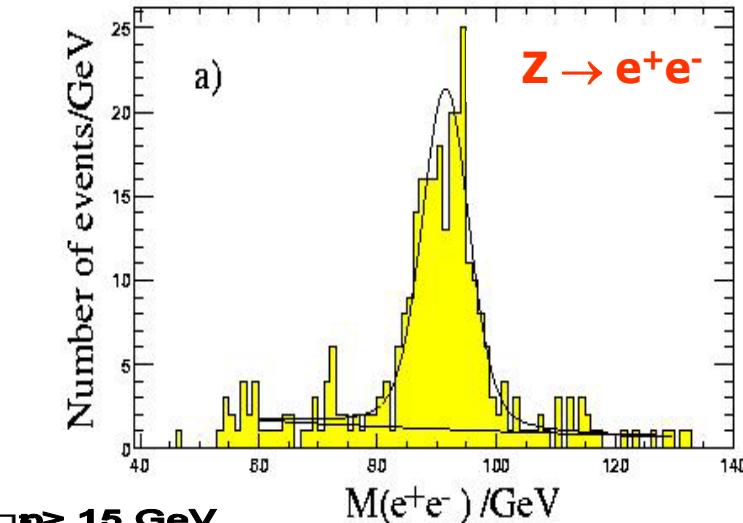
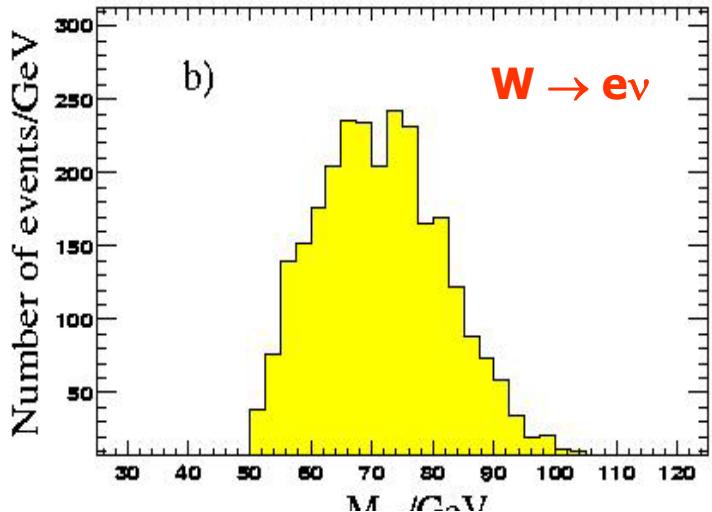
4561 candidates in 16 pb^{-1}

$$\sigma \bullet B(W \rightarrow \mu\nu) = 2.70 \pm 0.04_{\text{stat}} \pm 0.19_{\text{syst}} \pm 0.27_{\text{lum}}$$

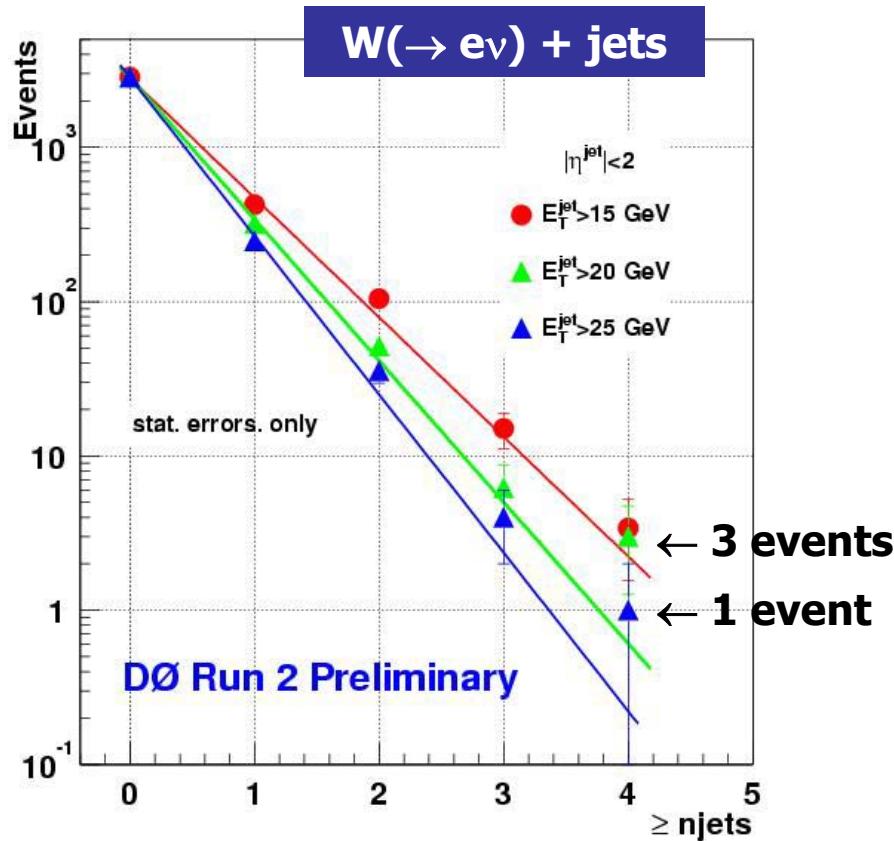
Run 1 scaled to 1.96 TeV: $2.72 \pm 0.02_{\text{stat}} \pm 0.09_{\text{syst}} \pm 0.10_{\text{lum}}$

Toward M_W and M_{top} for M_{Higgs} constraints

W and Z bosons at D \emptyset



The Top Quark at D \emptyset



Improved top mass measurements will help to constrain the Higgs mass:

$$\begin{array}{ll} \Delta m_t & \\ 2 \text{ fb}^{-1} & \pm 2.7 \text{ GeV} \\ 15 \text{ fb}^{-1} & \pm 1.3 \text{ GeV} \end{array}$$

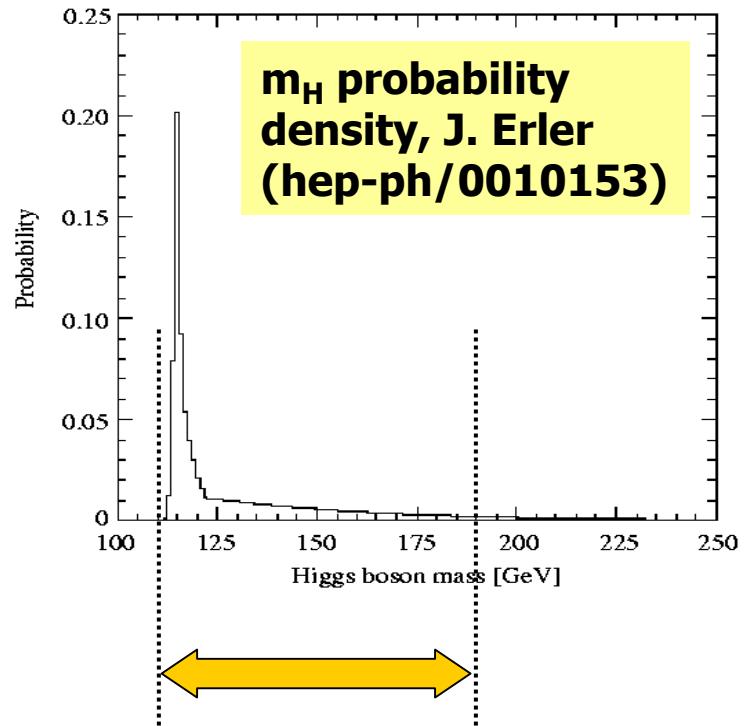
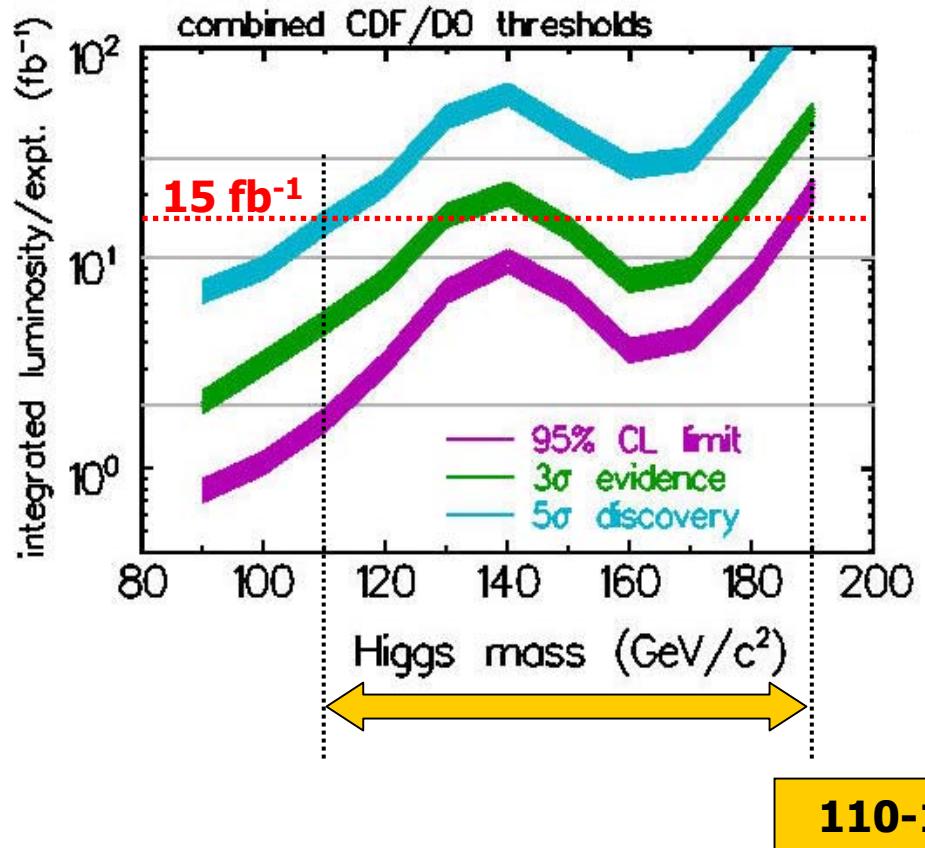
In contrast to the W, we can look forward to improved precision on m_t in the near future

- More data (few hundred pb $^{-1}$)
- Improved techniques

- $W \rightarrow e\nu + \text{jets}$

CDF and D0 have the world's only sample of Top Quarks to Study

Tevatron Higgs mass reach



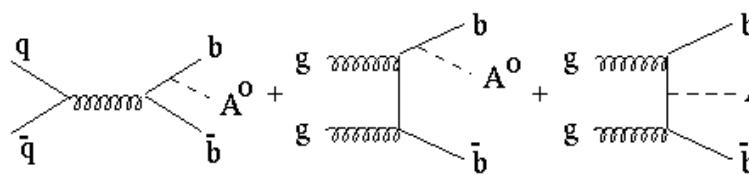
Low Mass Higgs Most Interesting

Higgs Reach in Run2

- Exclude at 95%
 - 2 fb-1 115 GeV
 - 5.0 fb-1 115-125 GeV and 155-175 GeV
 - 10fb-1 115-180 GeV
- 3 Sigma Signal
 - 5 fb-1 at 115 GeV
 - 10fb-1 at 115-125 GeV and 155-170 GeV
 - 15 fb-1 at 115-175 GeV all range

Higgs SUSY Production at the Tevatron

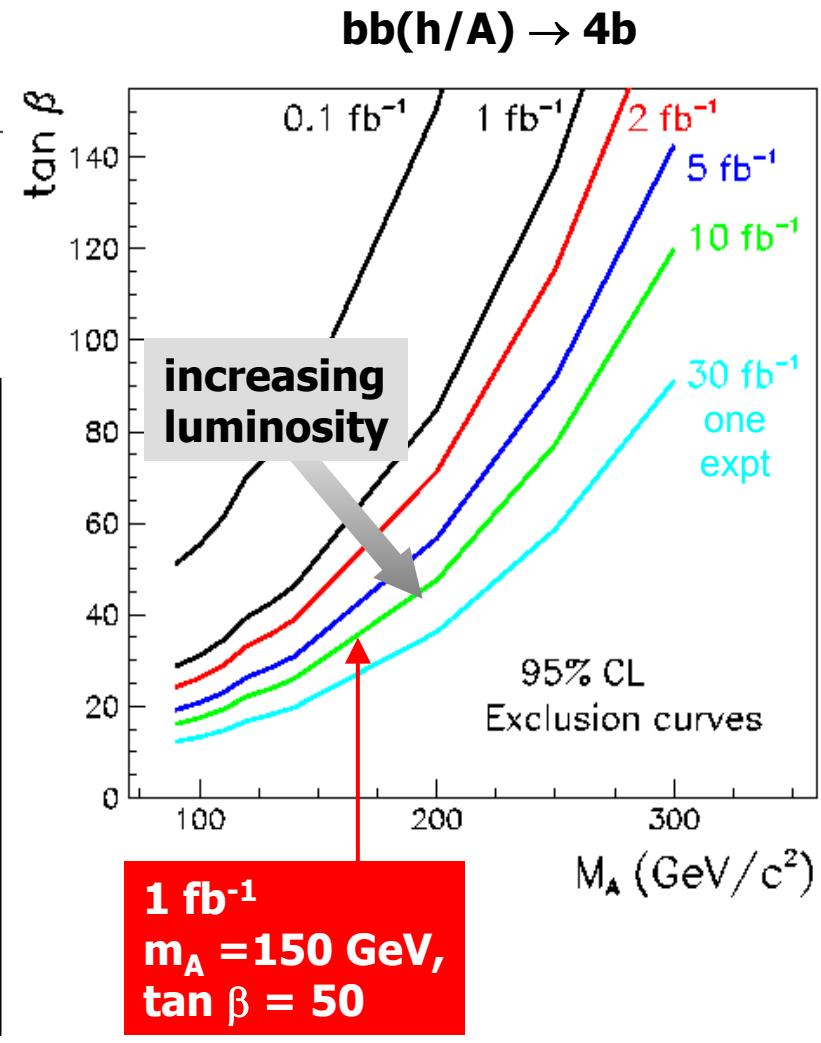
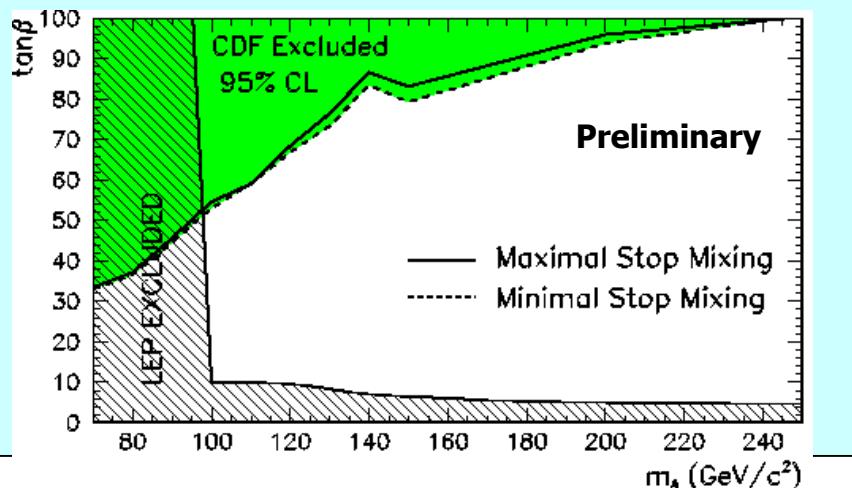
- $bb(h/H/A)$ enhanced at large $\tan \beta$:



**CDF Run 1 analysis (4 jets, 3 b tags)
sensitive to $\tan \beta > 60$**

- $\sigma \sim 1 \text{ pb}$ for $\tan \beta = 30$

$$m_h = 130 \text{ GeV}$$

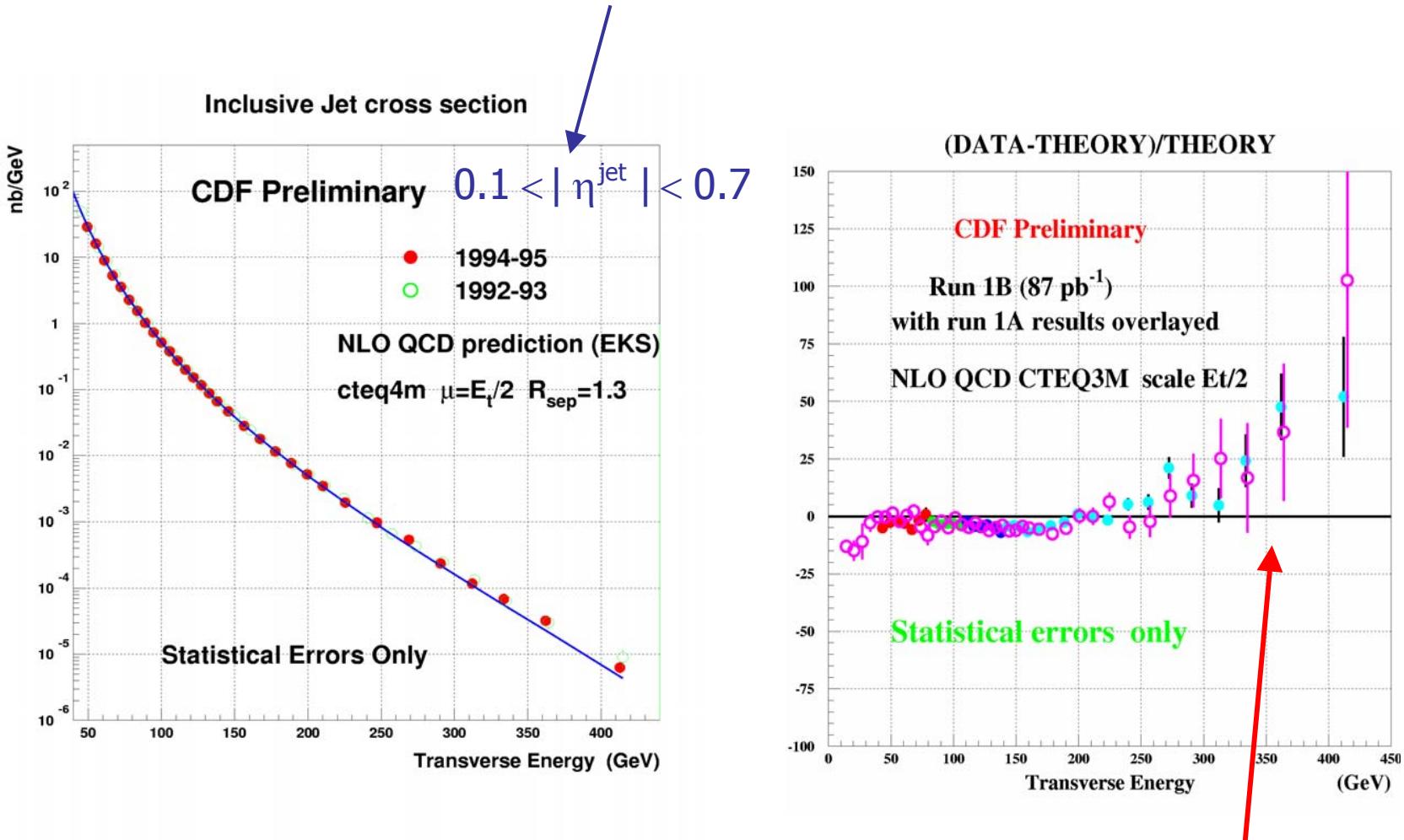


Experiments will guide Theory?

CDF: Anomalies in Run I data

- Cross section at high E_T jet
- Top dilepton - kinematics
- ee $\gamma\gamma$ Missing E_T - SUSY?
- W + 2-b jets - excess

Run1 Jet Cross Section



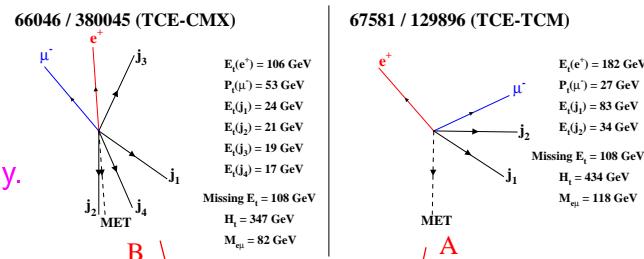
Data over ~ 7 orders of magnitude
Run1a and 1b results consistent ..

Observed deviation in tail
is this a sign of new physics ?

TOP Dilepton Events

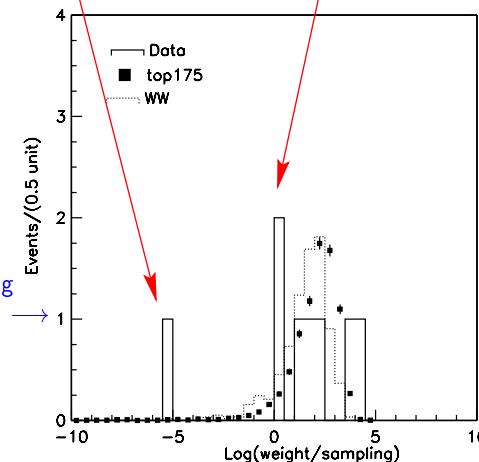
- Two of the 9 $t\bar{t}$ dilepton candidates do not fit well to the $t\bar{t}$ hypothesis, or to SM backgrounds. This has been discussed before (e.g. by Barnett and Hall in PRL 77,3506).

Event A: j_2 passes all tight electron cuts but fails because of proximity to detector boundary.
 \Rightarrow possibly trilepton event.



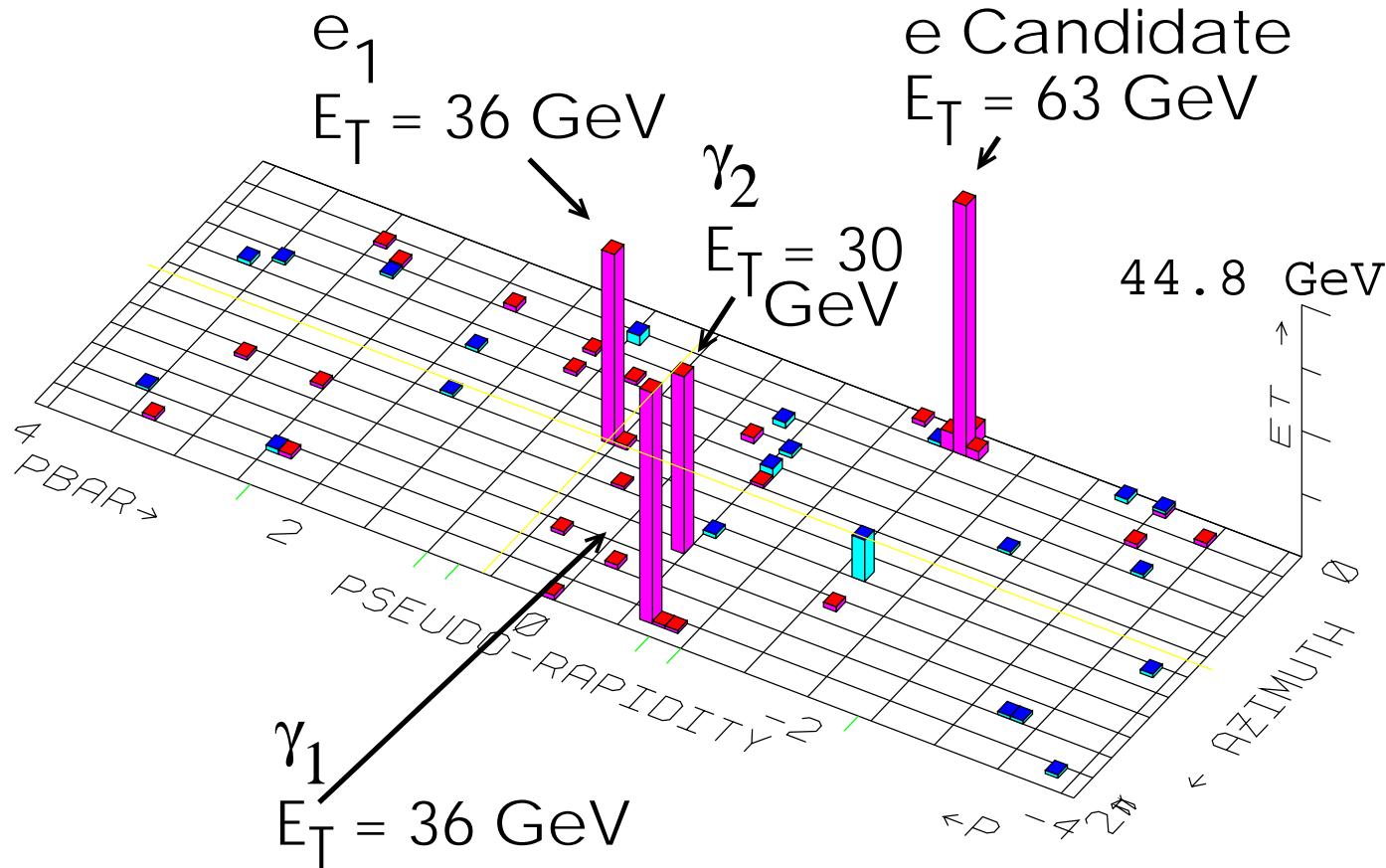
Event B: Large Missing E_T despite the 2 leptons is difficult for any SM process to explain.

Total reconstruction weights for the ν weighting done in the CDF dilepton mass measurement →
(averaging over distribution at least that “BB” yet at least 1 event is seen in ~ 5% events)



- Many people have calculated probabilities for various characteristics of these 2 events, but difficult to judge significance after the fact....

Hard to Understand this Event



$$E_T = 55 \text{ GeV}$$

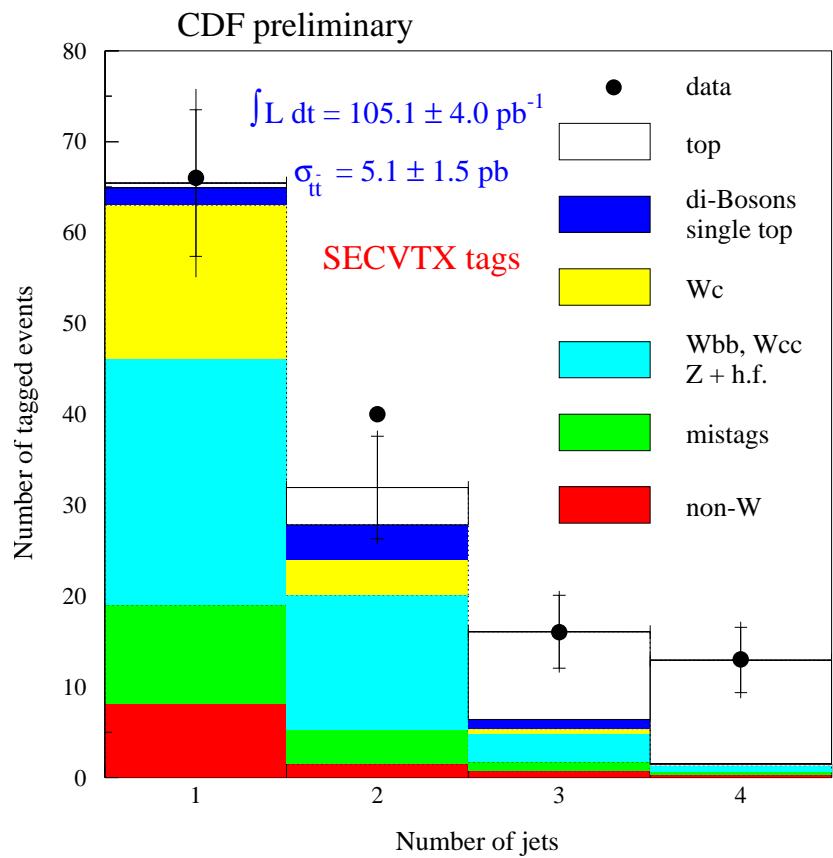
W+2Jets

fMRI principle

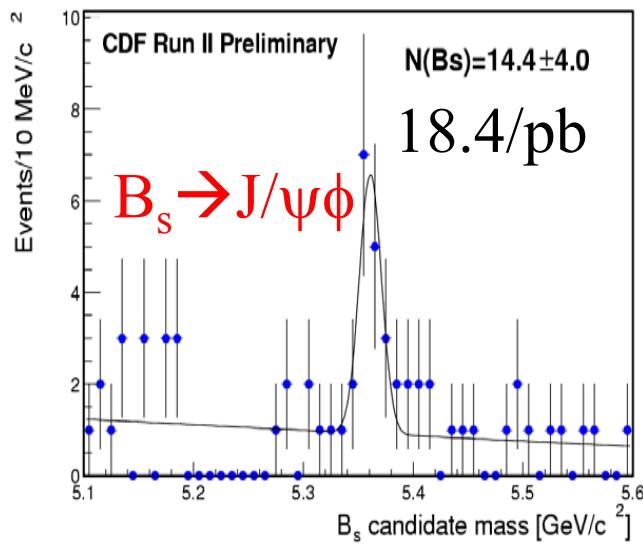
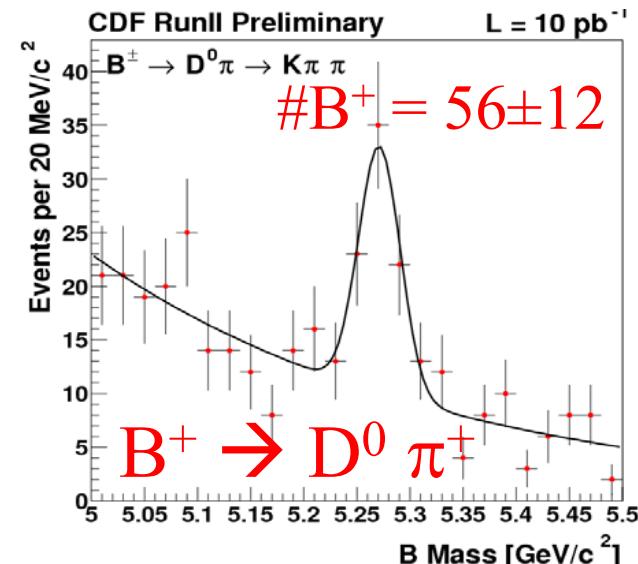
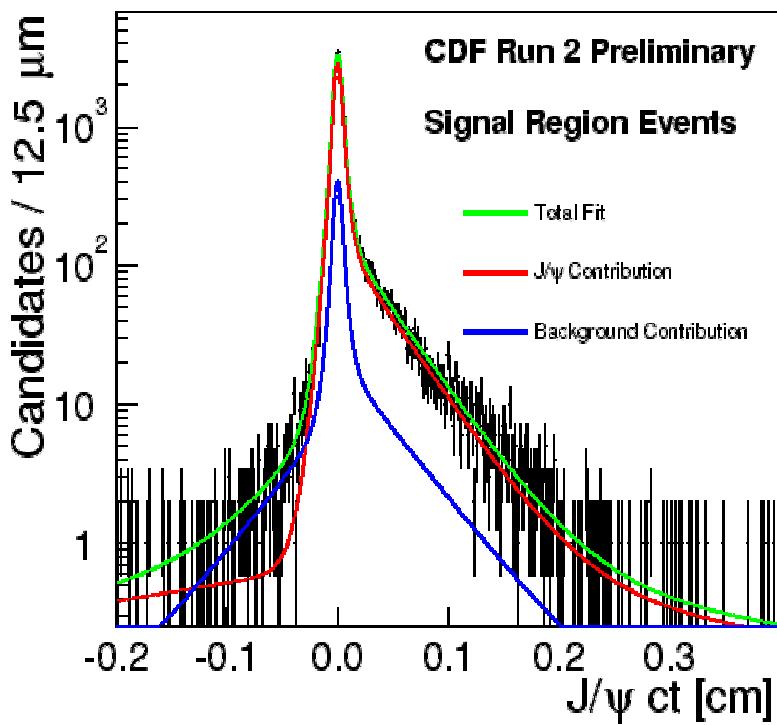
www.SEG.org/VTX

- Observed excess of b-tags in the 2 jet bin
 - Too many double tags
(more than one b-tagged jet/event)
 - Too many multiple tags
(more than one b-tag/jet)

→ A lot of speculation, but nothing solid.



Toward B_s mixing using $B_s \rightarrow D_s \pi$

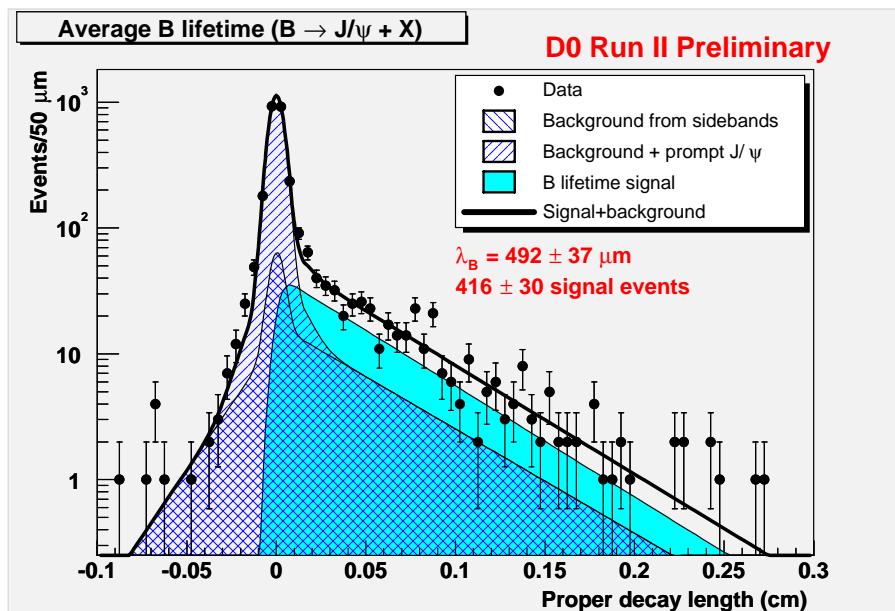


- Inclusive B lifetime with J/ψ 's
 $c\tau = 458 \pm 10_{\text{stat.}} \pm 11_{\text{syst.}} \mu\text{m}$ (PDG: $469 \pm 4 \mu\text{m}$)
- Exclusive $B^+ \rightarrow J/\psi K^+$ lifetime
 $c\tau = 446 \pm 43_{\text{stat.}} \pm 13_{\text{syst.}} \mu\text{m}$ (PDG: $502 \pm 5 \mu\text{m}$)

B Physics at DØ in Run II

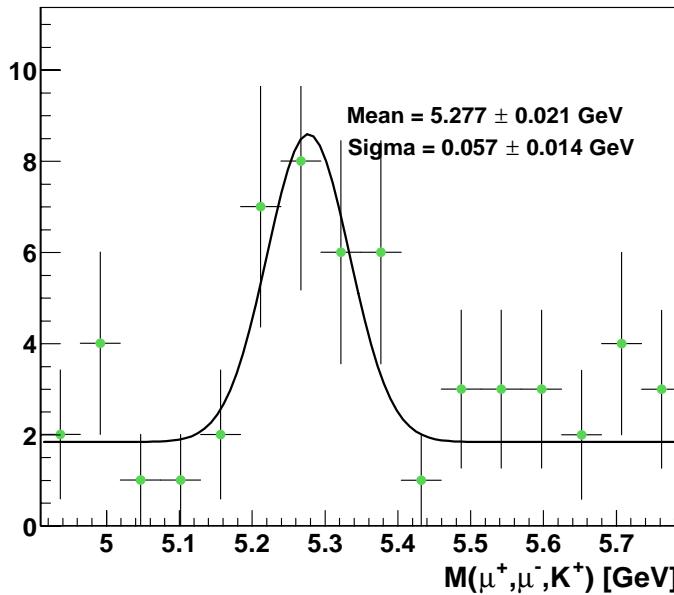
Putting the tools in place:

- $J/\psi \rightarrow \mu^+ \mu^-$
- $J/\psi \rightarrow e^+ e^-$
- $K_s \rightarrow \pi^+ \pi^-$
- **B tagging**
 - muons
 - electrons (**working on it!**)
 - displaced vertices



$$\tau(B) = 492 \pm 37 \mu\text{m}$$

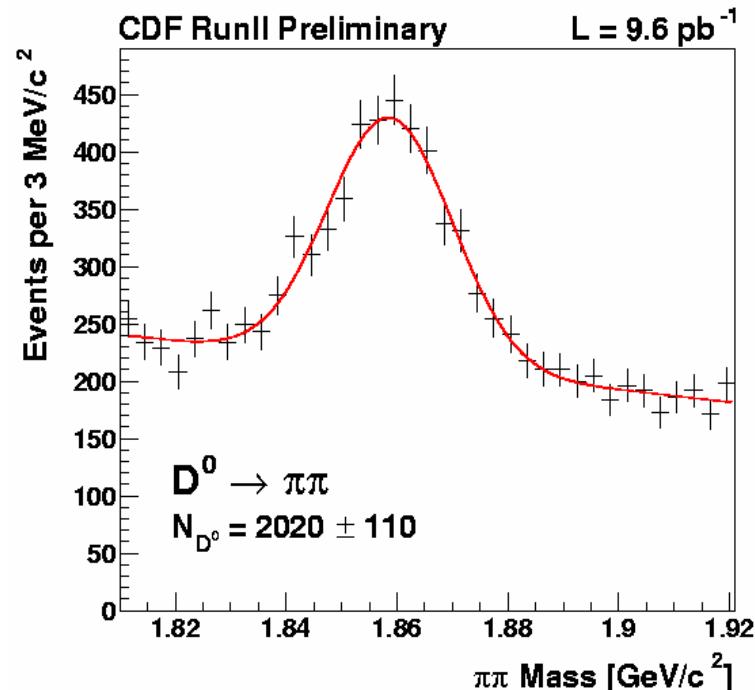
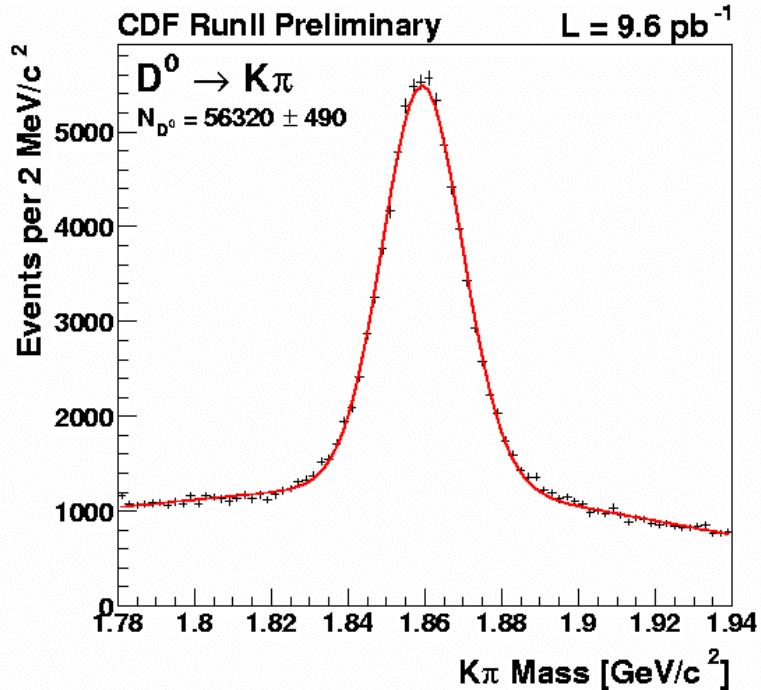
DØ's First B mesons: $B \rightarrow J/\psi K^\pm$



DØ cannot exploit purely hadronic triggers, but benefits from large muon acceptance, forward tracking coverage, and ability to make use of $J/\psi \rightarrow e^+ e^-$

SVT selects huge charm signals!

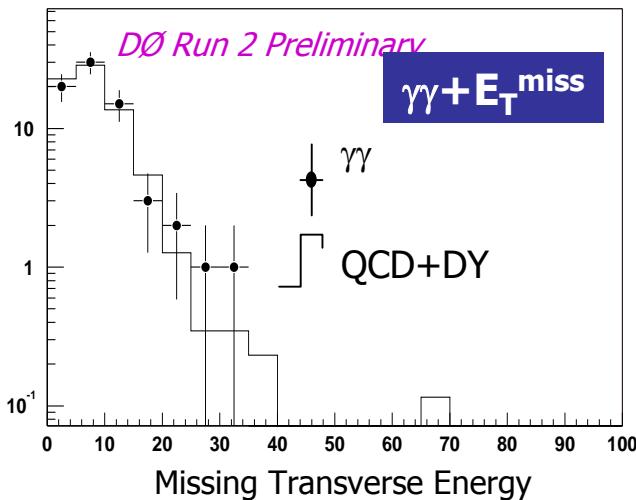
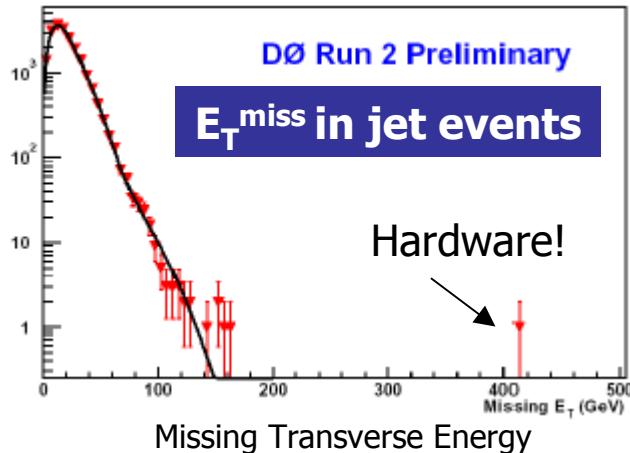
10 Million reconstructed charm in Run 2a (2fb-1)



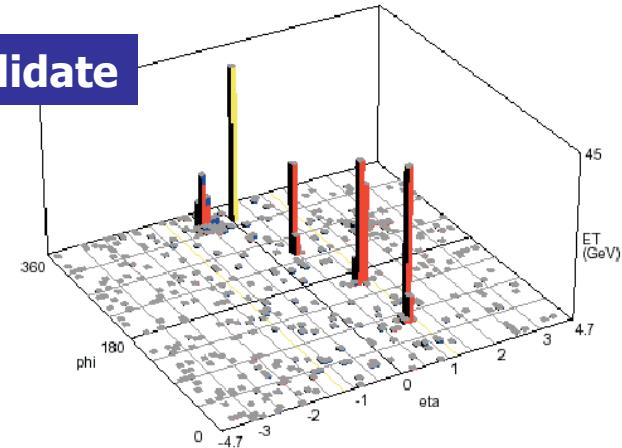
- $\Gamma(D \rightarrow KK)/\Gamma(D \rightarrow K\pi) = (11.17 \pm 0.48 \pm 0.98)\%$ (PDG: 10.83 ± 0.27)
- $\Gamma(D \rightarrow \pi\pi)/\Gamma(D \rightarrow K\pi) = (3.37 \pm 0.20 \pm 0.16)\%$ (PDG: 3.76 ± 0.17)

Already comparable!

D0 SUSY searches in Run II



Trilepton candidate



First Run II SUSY limit

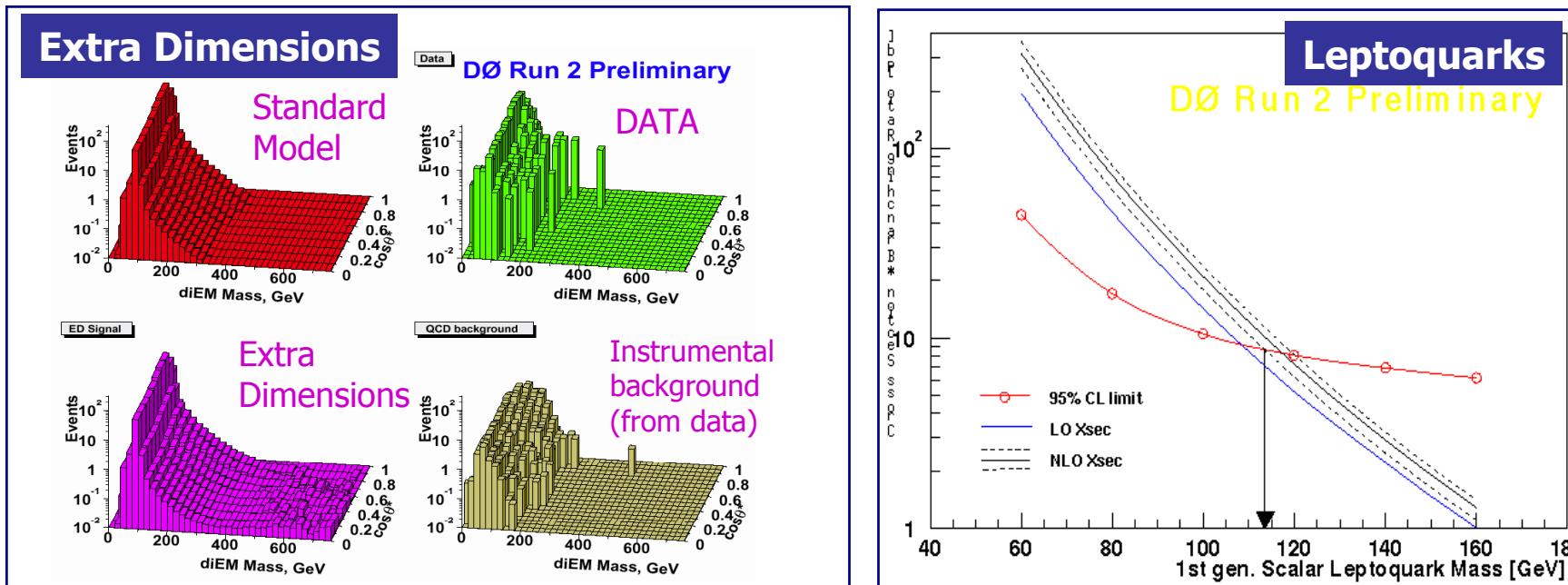
Gauge mediated SUSY $\bar{p}p \rightarrow \gamma\gamma + E_T^{\text{miss}}$
Cross section for $\gamma\gamma + E_T^{\text{miss}} > 0.9\text{pb}$

Run II limits are not yet competitive, but
show we are ready for this physics

Run II
students are
graduating



D0 Other new phenomena in Run2



Run II limits from $\bar{p}p \rightarrow ee, \mu\mu, \gamma\gamma$
 $M_S(\text{GRW}) > 0.92 \text{ TeV } (ee/\gamma\gamma)$
 $M_S(\text{GRW}) > 0.50 \text{ TeV } (\mu\mu)$
 (first limit from a hadron collider
 in this channel)

First generation leptoquark
 Run II mass limit
 $M_{LQ} > 113 \text{ GeV}$
 for $B(LQ \rightarrow ej) = 1$

Why Run 2?

- Tevatron is the Energy Frontier
- LHC is the Future 2007+commissioning
- CDF&D0@2005-well understood Instruments
- Powerful detectors-designed to 4E32
- Gain=6.5/0.1x1.35(c.s.)x2(si accep)x1.3(cal)
- Factor > 200-400 sensitivity over run 1
- Tremendous opportunity for discovery